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Materiel Distribution

Improving Support to Army Operations in Peace and War

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PREFACE

This document chronicles an Arroyo Center study of materiel distribution in the Army. This study was sponsored by the Strategic Logistics Agency, Deputy Chief of Staff for Logistics, and the Combined Army Support Command within the Training and Doctrine Command. Although Army materiel distribution constitutes the primary focus of this study, the cross-service nature of the requisition-to-receipt process led us to examine the performance of elements of the process outside the Department of the Army. This document grew out of a project briefing given to numerous people in the Department of Defense and industry, and it reflects many of the comments received during those briefings. This study should interest anyone concerned with distribution practices in the Department of Defense.

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SUMMARY

BACKGROUND

An Army study of DoD distribution reveals a catalogue of chronic problems. In previous conflicts, users of the system habitually resubmitted, over and over, the same orders for the same part or supply. Backlogs swelled at both CONUS and theater ports. Documentation about what had been shipped and received was, at best, spotty. Despite high-level attention and repeated attempts to correct the problems, operations Desert Storm and Restore Hope show that they continue to exist.

The conditions that have allowed the Army to work around distribution problems are fast disappearing. Force reductions will shrink the Army from 18 divisions to 10 or fewer. Thus, the large pool of parts, equipment, and manpower that has been drawn on to support past operations will disappear. Furthermore, the nature of operations will probably change. Units in Operation Desert Storm had months to prepare. But short-notice operations will not provide the luxury of time to establish stockpiles of supplies in the theater. In future contingencies, units will have to depend on the distribution system.

PURPOSE OF THE RAND STUDY

To address the above distribution problem, RAND has undertaken this study to analyze the current Army materiel distribution process, quantify the extent of problems, and identify new concepts that offer the most promise for improving support to Army operations in peace or war.

THE DISTRIBUTION PROCESS

The structure of the entire distribution process is complex, segmented, and disjointed. It is complex because it involves many nodes and organizations. The process is segmented because the various functional aspects of distribution—e.g., storage, issue, transport—divide among various organizations. Further, the process is not a well-integrated set of activities. Some fall to transportation organizations, others to supply agencies. Some functions occur within services, and others belong to joint organizations. The complexity and segmentation tend to give the distribution system a vertical rather than a horizontal focus. That is, each stage of the process tends to concentrate on its own function. The managers are interested in meeting their segment's performance measures, perhaps to the detriment of the overall system performance.

CHANGING WORLD OF DISTRIBUTION

Several aspects of the world have changed in ways that have significant implications for the distribution system. The past 30 years have seen major changes in the cost of some materiel and transportation. Computing and communication costs have also declined, while capabilities have increased. Over the same period, the cost of some of the materiel used in weapon systems has increased dramatically.

While the cost of materiel has been dramatically increasing for some items, the cost of transportation has been decreasing significantly. Shipping costs for all modes (in constant dollars) have dropped sharply. Twenty-five years ago, it cost more than twice as much to ship materiel by sea or truck as it does today. Air and rail shipment costs are also much lower. The current DoD distribution process has not adapted to take advantage of these dramatic cost declines.

CHANGES IN INDUSTRY

Industry has experienced these same changes to the business environment. The best-performing companies have taken advantage of the changes. They have made themselves more competitive by changing their business processes and investing in technology to support the new processes. This includes using technology to automate procedures. But technology alone does not provide sufficient productivity gains. Automating a cumbersome procedure may make it faster, but it will be no less cumbersome. The greatest productivity gains occur when the system is reengineered and automated simultaneously. In spite of many differences between commercial distribution and that of DoD, many of industry's practices can apply to DoD.

CONCLUSIONS

We have learned so far that

- DoD distribution is complex and compartmented.
- It is slow, and the problems affecting it are longstanding.
- Fixing it requires a systemic approach; stovepipe approaches have not worked.
- The Army distribution system has evolved over many years, and may have been good at one time. But its design now rests on invalid assumptions.
- The best commercial firms have met and overcome many of the challenges confronting the DoD. We have observed the following aggregate level strategies at successful companies:
 - Define business focus and core competencies

- Focus on customers
 - Establish well-defined customer-supplier relationships
 - Establish process managers
 - Change process, organizations, and procedures and leverage technology to meet customer needs
 - Establish ambitious goals and measure performance
- Their approach is a useful model for the DoD to explore

No single approach or technique will save large amounts of money or solve DoD's logistics performance, because problems pervade the process. Industry is achieving dramatic reductions in costs and improvements in performance, and opportunities exist for DoD to gain similar benefits. But to achieve them, DoD needs to make current processes work better in the short term and, in the long term, change its processes to take advantage of technology.

RECOMMENDATIONS

If the Army and DoD want to improve the materiel distribution process, they must take five actions immediately:

- Seek a broad consensus on the need for substantial change.
- Make a long-term (five-year) management and financial commitment to change.
- Create a task force of key commanders who will work with the system's customers to specify distribution goals to meet future requirements and provide the leadership needed to improve the system.
- Form a team with industry to redesign the distribution process to meet the goals.
- Establish consensus among all participants on the new process and new measures of performance.

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ABBREVIATIONS

AMDF	Army Master Data File
APOE	Aerial Port of Embarkation
BRVI	Buy Response Vice Inventory
CCP	Consolidation and Containerization Point
CRP	Central Receiving Point
DBOF	Defense Business Operating Fund
DLA	Defense Logistics Agency
DVD	Direct Vendor Delivery
ITV	In-Transit Visibility
LCA	Logistics Control Agency
LIF	Logistics Intelligence File
LOGSA	Logistics Support Agency
MIPS	Millions of instructions per second
MRO	Materiel Release Order
NICP	National Inventory Control Point
NSN	National Stock Number
ODS	Operation Desert Shield/Storm
OSC	Objective Supply Capability
POD	Port of Debarkation
POE	Port of Embarkation
TAV	Total Asset Visibility
TP	Transportation Priority
UMMIPS	Uniform Materiel Movement and Issue Priority System

1. INTRODUCTION

BACKGROUND

One frequently heard opinion of the materiel distribution process¹ holds that "it gets the job done." Those advancing that argument point to Operation Desert Storm (ODS) both as an example of an impressive logistical feat and as testimony to the effectiveness of the distribution process. The Persian Gulf War certainly highlighted the exceptional performance of U.S. weapon systems. Less visible, however, was the poor performance of DoD's materiel distribution process.

Implicitly, this "gets-the-job-done" view questions the need to change the current process radically. Although accurate enough, such a perspective does not address a number of problems with the process, problems that only promise to loom larger as the Army shrinks dramatically² and shifts from its historical focus on Europe to a contingency orientation. The argument that the current process "gets the job done" does not question how the job got done, how long it took, or how many resources were used in the process.

Furthermore, one capability that has allowed the Army to solve distribution problems is fast disappearing. Traditionally, the Army has been able to achieve logistics mass because it had substantial forces that were not committed to the current conflict. These uncommitted forces provided a pool of people and materiel to draw from to fill long pipelines, to overfill authorized stocks, to track down scarce materiel and missing orders, and to work around the standard distribution system.

Tomorrow's forces will be much smaller. For example, the Army will decline from its Cold War level of 18 divisions to 10 or fewer. Fewer resources, such as end items, stock, and manpower, will be available to compensate for shortfalls in the performance of the distribution system. Thus, future shortfalls in distribution support to the Army could affect its warfighting capabilities.

Moreover, ODS may not typify future contingency operations. The United States had six months and plenty of people and resources to get ready to fight. In future contingencies,

¹The materiel distribution process begins with a requisition at the unit level to various echelons of supply for materiel (spare parts, clothes, food, etc.) and ends when the materiel is received by the ordering unit. In this report we focus on requisitions filled from wholesale supply.

²DoD's budget has decreased 20 percent in the last five years.

the United States will not have as many people and resources and may not have time to work around problems.

Past Performance

A review of the performance of DoD distribution in past conflicts suggests that many problems are chronic and systemic and that they fall beyond the capability of any one organization to correct. An analysis of 40 years of distribution problems—extracted from reports on the conflicts in Korea, Vietnam, Persian Gulf, and Somalia—shows startling similarity. A summary of these problems appears in Table 1. Despite past attempts by various DoD organizations to correct shortfalls in distribution, the problems have stubbornly persisted, particularly lengthy resupply times.

An analysis of ODS logistics operations reveals problems similar to those found in previous conflicts. The air port of embarkation (APOE) became so backlogged with high-priority sustainment cargo that logisticians lost track of both orders and materiel—a large amount of materiel was repacked into sea vans without documentation and shipped by surface (Matthews and Holt, 1993, pp. 20–22). This action contributed to the need to open 25,000 of the 40,000 containers sent to Saudi Arabia simply to determine what was in them. Visibility of expensive, high-priority materiel was lost at the APOE, and in some cases it was not regained until the shipment returned to the United States months later. Resupply was so poor that at least one Army brigade did not repair a single tank with parts received through regular *wholesale* supply channels for the duration of its deployment.

Table 1
Distribution Problems Noted in Previous Conflicts

Problem	Conflict			
	Korea	Vietnam	Persian Gulf	Somalia
Supplies lost	Yes	Yes	Yes	Yes
Long requisition-to-receipt times	Yes	Yes	Yes	Yes
Multiple reorders of same part	Unknown	Yes	Yes	Yes
Backlogs at CONUS and theater distribution nodes	Yes	Yes	Yes	No
Poor documentation of inventory and receipt	Yes	Yes	Yes	Yes

These systemic problems suggest that the old logistics strategy based on mass will not work given the national security strategy shift from forward deployment to power projection and the continuing budget cuts that are reducing forces. Moreover, the old ways of trying to fix distribution problems have not worked. DoD's materiel distribution process has to change, and new ways to change it must be found.

We have observed leading companies adapting to similar changes and think they may provide DoD with both direction and the means for getting there. Granted, DoD's distribution tasks are more challenging than those in the private sector. It has large and random surges in demand, during which customers deploy to remote locations and, once there, continue to move. But many of the problems we observe are in the wholesale system, which is less affected by these events. It has been difficult for industry to change, and it will probably be even more difficult for DoD.

PURPOSE AND METHOD OF THE RAND STUDY

Our goal is to make the case for further changes and to identify at an aggregate level concepts that offer the most promise for improving support to Army distribution operations.

This effort blends a quantitative analysis of DoD materiel distribution with a systems analysis of the process. We use quantitative data to describe how the system performs and to identify those areas where the system could most benefit from improvement. Most of the quantitative information about system performance is drawn from the Army's Logistics Intelligence File. So the analysis is limited to requisitions filled from wholesale supply.

In our analysis of the process, we take a systemwide approach to Army distribution from requisition to receipt. However, we focus on the process during peace as well as war, particularly from requisition to the CONUS port. We look at organizational structures and management systems and how they affect performance. We examine the structure because each step in the distribution process adds time and cost. Therefore, if it is to be justified, each step's value added should exceed its time and cost. We also identify where the authority, responsibility, and accountability for distribution currently exist in the structure and the extent to which they may be misplaced or underallocated. Although we focus on the Army, any study that examines materiel distribution from requisition to receipt must expand beyond any one service or agency.

As a second aspect of our process analysis, we examine the measures of performance used by the system. Performance measures tend to drive behavior; therefore, we attempt to determine how current measures relate to customer support, mission performance, and other aspects of distribution performance, and to determine what needs to change to coordinate the

effort of all involved DoD organizations. As Eliyahu M. Goldratt (1990, p. 26) has observed, "Tell me how you measure me and I will tell you how I will behave. If you measure me in an illogical way, do not complain about illogical behavior."

As a third dimension of our process analysis, we also examine the impact of constraints on the distribution components. The priority system the Army uses does not address the problem of constraints. If high-priority supplies overwhelm system capacity at the consolidation and containerization points and at the ports of embarkation and debarkation, as they did in ODS, priorities lose meaning. The system must provide for both recognizing constraints and then proactively managing them.

Having examined the DoD system from a quantitative and system perspective, we compare it with industry. We are looking broadly for alternative ways to improve DoD distribution performance. We seek to determine whether the best business practices offer alternatives that would improve distribution performance, particularly in time and cost, within DoD.

HOW THIS REPORT IS ORGANIZED

In the next section of this report, we examine the performance of the distribution process during ODS and analyze the effect of performance on customer behavior. In Section 3 we analyze some of the major changes in the world that have affected both military operations and commercial business practices. In Section 4 we compare DoD performance with one company. In Section 5 we discuss six strategies to adapt industry changes to DoD. In Section 6 we summarize our conclusions and make recommendations.

2. ANALYSIS OF DISTRIBUTION PERFORMANCE

The distribution process begins when an Army customer orders (requisitions) material that is not available locally (in retail stock) and ends when the customer receives the ordered material. Anecdotal evidence suggested that this process performed poorly during ODS. We set out to define the distribution process and measure its actual performance (both responsiveness and reliability) during ODS. We extended the analysis to peacetime performance as well as Operation Restore Hope, which was much less demanding on the distribution process than ODS. We begin with an overview of the process.

THE DISTRIBUTION PROCESS

The Army distribution process has evolved incrementally over the past 30 years, adding steps and layers but not radically changing the process. Its performance may have been the best at the time it was developed, but now, as we will show, it is slow and unreliable, particularly compared to leading commercial firms.

Figure 1 presents a somewhat simplified picture of the Army distribution process. It does not contain every node nor every information system or measure of effectiveness. For the purpose of this discussion, we separate distribution from the repair and procurement processes. We realize that these processes are interrelated from the customer's perspective. Our analysis focuses on the processes performed when items are in stock. If the process does not work when items are in stock, it certainly will not work better when they are not.

The details of this process—the meaning of the acronyms, identification of the nodes—are not important. The purpose of the diagram is to illustrate two aspects. First, the process is complex, and second, the focus of the players in the process tends to be vertical rather than horizontal.

The Army distribution process is complex because it has numerous segments and nodes, and these segments and nodes are controlled by different services, different organizations within the services, federal agencies outside of DoD, and commercial companies. Each of these several organizations has different missions, performance measures, and independent data systems. Furthermore, the distribution process contains multiple paths. It has a number of depots, inventory control points, and different transportation methods. Many of the nodes are geographically dispersed and located in isolated areas.

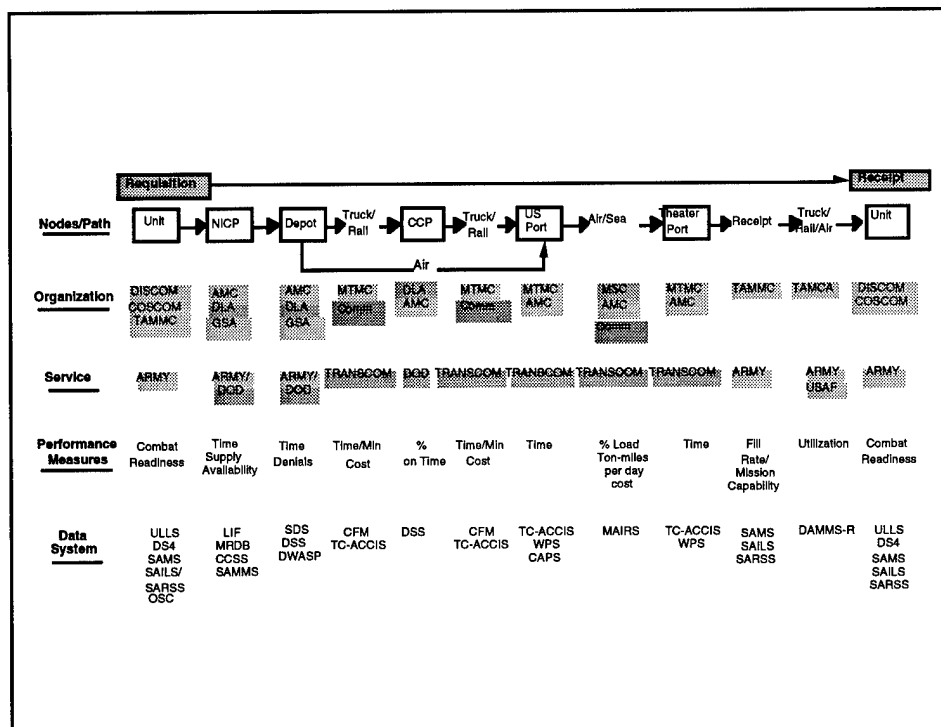


Figure 1—The Distribution Process

The focus of performance measures within the distribution process tends to be more vertical than horizontal. The managers at each stage of the process are primarily interested in meeting narrow performance measures, perhaps to the detriment of overall process performance, cost, and, ultimately, the customer. For example, the manager of an individual segment may be measured by transportation costs and will consolidate parts shipments to achieve better shipping rates. But consolidating orders increases the total requisition-to-receipt time and hence inventory costs. It could also affect mission capability. Hence, optimizing one segment may be suboptimal for the overall process.

Vertical systems tend to be inflexible and unresponsive. Because functions are compartmentalized, total system requisition and materiel status information are difficult to gather. For example, historical Army requisition data are gathered into the Logistics Intelligence File (LIF), but that information is not readily available to the customer in a timely manner. Nor does that information flow in a timely manner to the ports of embarkation or debarkation for, say, workload projection and management. Instead, the ports rely on forecasts based on past or planned—but not actual—workload. One effect of this compartmentalized information is the inability to quickly and accurately project and

balance airlift or sealift requirements with available capacities to manage bottlenecks. Thus, the process cannot adapt in time to avoid long queues and backlogs.

DoD distribution components are meant to operate as a smoothly functioning team. Unfortunately, as we indicated, experience has demonstrated otherwise. Organizations with a horizontal focus measure *process* as well as *segment* performance. As we will discuss later, the distribution processes of top-performing companies have fewer, smoother, and quicker information and materiel flows. The distribution process can be regarded as an overhead function supporting troops in the field. Many commercial companies, focusing on satisfying their customers, have reduced their logistics overhead costs and processing time as a way of increasing productivity, quality, and overall responsiveness. They have found that the more hand-offs in the process, the greater the potential for delays, queues, additional handling and transportation costs, and so forth. A horizontal focus concentrates on the ultimate goal: delivery of the right item to the soldier at the right time, every time.

We now look in more detail at the performance of the distribution process.

DISTRIBUTION DURING ODS

ODS logistics operations have been widely lauded as a tremendous feat. And, indeed, they were. However, this does not mean that they could not have been better or that current procedures will work as well in the next contingency operation. Some of the successes occurred only because people were able to work around the process.

Even though the distribution process moved a tremendous amount of materiel, it did not meet its own standards. Figure 2 shows the Uniform Materiel Movement and Issue Priority System (UMMIPS) time standards, Persian Gulf experience in days to the port of embarkation (POE), and a recent period of normal peacetime operations for high-priority, in-stock (i.e., no backorders) orders as reported by the Army's Logistics Control Agency (LCA). Unfortunately, accurate actual times for the Gulf War are available only through the POE (the shaded portion of the diagram at the top of the figure). After the POE, the data become sparse because documentation took a back seat to delivery.

Today, commercial companies tend to think of high-priority delivery as 24 hours. The UMMIPS standard for getting high-priority items to the port is five days. During ODS, it took on average 35 days or more to reach the POE, which is seven times as long as the UMMIPS standard for these items. They should have been received by the customer long before the time it took them to reach the POE. Note that UMMIPS standards are maximum times, but the LCA, which has data for individual orders, only reported *average* times.

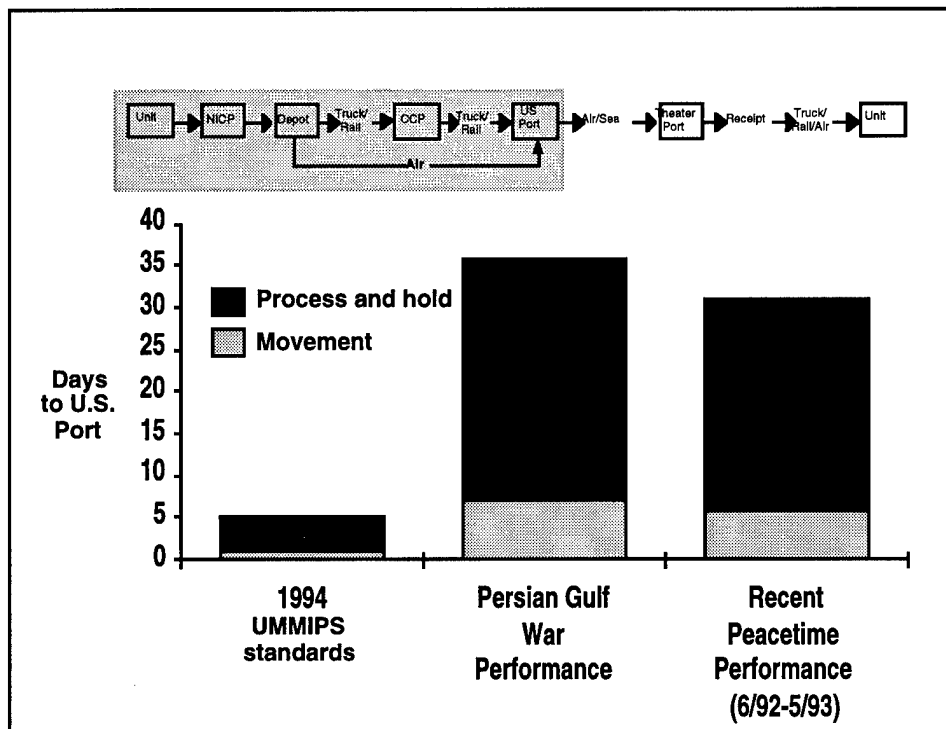


Figure 2—DoD High-Priority Standards and Performance When Materiel Is in Stock

Customers actually got some orders early, some on time, and some very late. Thus, from the customer's perspective, the distribution process performs erratically.

One might argue that the Persian Gulf War was a major contingency involving large forces and substantially increased demands. Thus, the process got overloaded and could not meet its standards. However, the third bar in the figure shows the result of peacetime performance, and it does not differ dramatically from the ODS performance.

Figure 2 also shows how the time it took an order to reach the POE divides between movement (light shading) and processing and hold (dark shading) as reported by the Army's LCA. Processing and hold time includes the requisition or materiel processing period spent at any of the following locations:

- In-theater
- National Inventory Control Point (NICP)
- Depot
- Consolidation and containerization point (CCP)
- POE

The division of times between movement versus processing and hold is not perfect because we are restricted by the coarseness of the actual data elements.

Clearly, the bulk of the time is spent in processing and hold, which by itself exceeds the UMMIPS standards (25 of the 35 days required during ODS). Thus, even shortening the movement time to zero will not solve the current distribution problem. Ships and planes move at their normal speed, regardless of whose cargo they carry. Any strategy to improve distribution times must address these lengthy process and hold times. It is probably worthy of note that these lengthy times spent in processing and hold did not improve during the operation. In fact, as Figure 3 indicates, they got worse.

The figure shows how much time three segments of the distribution process took during three periods. An analysis of high-priority requisitions during ODS indicates that processing and hold averaged 22.2 days for the highest-priority items (priority 1-3) and accounted for 74 percent of the time required from requisition to receipt at the POE.³

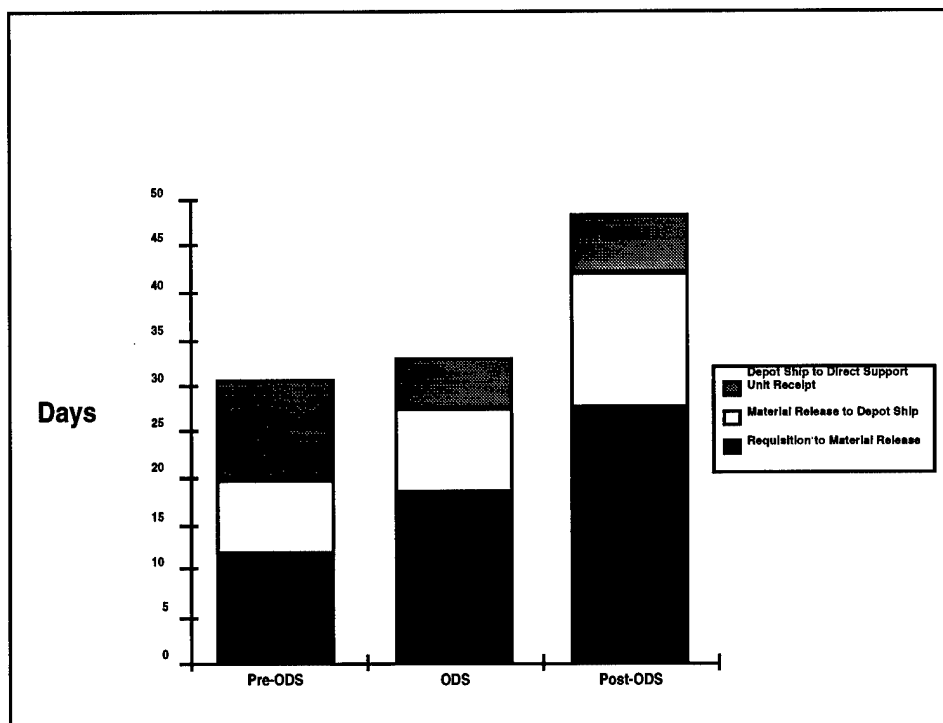


Figure 3—Increase of Processing and Hold Times

³Data obtained from Logistics Control Agency.

During ODS, the problems were worse, because several nodes in the process—such as the consolidation and containerization point and air ports of embarkation—were overloaded. But we have also observed backlogs during peacetime. One installation's central receiving point took as long as 11 days to deliver high-priority orders.

VARIABILITY IN PERFORMANCE

But total or average delivery times are not the only aspect of interest. It is also important to know how much times vary. If a process is slow but predictable, it can be planned for. However, an unpredictable process—particularly one into which the customer has limited visibility—cannot be planned for. To determine how much variation occurs in DoD distribution, RAND obtained 18 months of raw data from the Army's Logistics Intelligence File (LIF), which includes much of the ordering done for ODS. For those requisitions identified as part of ODS, we calculated the relative frequency of how long it took orders to get to the POE given that the materiel was in stock (i.e., no backorders). We include the average time to POE. Figure 4 displays these data.

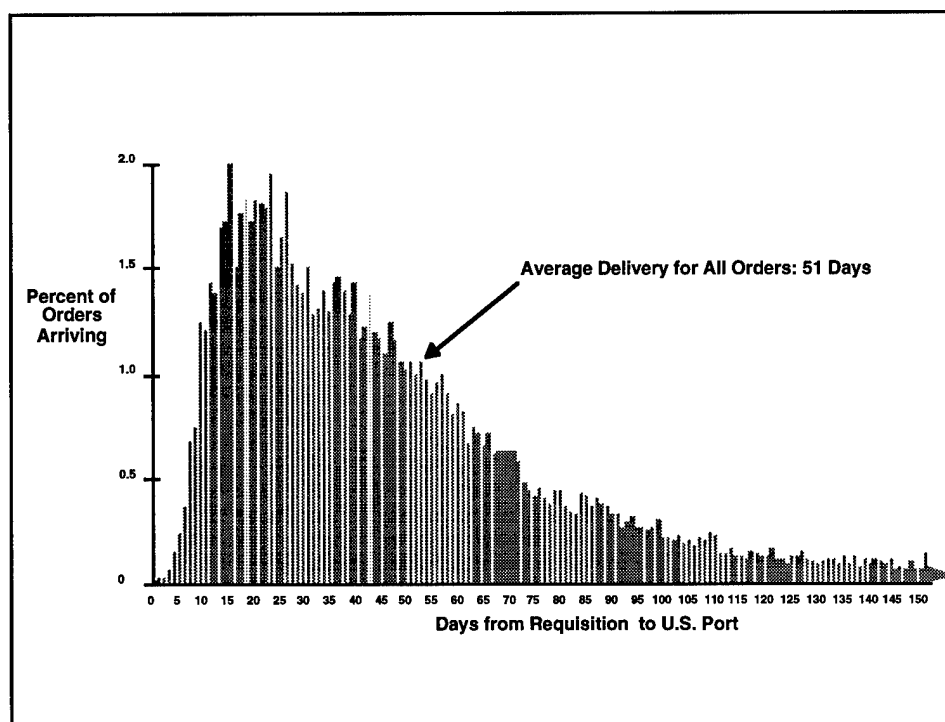


Figure 4—Time to Move to CONUS POE During ODS

Our estimated mean delivery time is 51 days, much higher than that estimated by the LCA because of differences in processing the data.⁴ Most striking is the high variability (long tail) associated with the relative frequency of days it took from the time an item was requisitioned until it reached the POE in ODS.⁵

Note that we truncated the tail for display purposes; it extended well beyond 150 days. The Army customers do not see the average times reported by common performance measures. Rather, they see the actual times, which vary considerably from order to order. Their order could arrive in days, or it could take months. And if several items are needed to repair a piece of equipment, the latest arrival determines when the repair can commence. What is even worse, there is no easy way to find out when an order will arrive. Current Army information systems can tell a customer where an order was (i.e., they are backward looking), but do not (and cannot with any certainty due to the high variability in each segment of the process) project expected arrival time.

We broke the data down into the individual time segments and plotted the relative frequency of times for orders to pass that segment. Figure 5 shows distribution curves similar to those in Figure 3. This suggests that the order delays occur throughout the distribution process and that no single change will correct the problem. Rather, changes are needed at every step in the process to improve overall process performance.

Because ODS produced such a large surge in orders, backlogs occurred at CCPs and the aerial ports in CONUS. We wanted to compare ODS with other contingency operations to see if the same problems appeared. Therefore, we obtained some raw data from the Somalia operation and normal peacetime operations, and performed a similar analysis for Class IX⁶ materiel. That is, we removed all backorders and looked only at orders for materiel in stock. The data appear in Figures 6 and 7 respectively for Somalia and normal peacetime operation. For Somalia, we also indicate who managed the item, the Army or DLA; the percent figures in the lower right-hand corner indicate the portion of the requisitions that fall beyond the latest day on the horizontal axis. So, for Somalia, slightly more than 1 percent of the requisitions remain unfilled at 49 days. Although our mean times from document date to POE lift decreased from our ODS value because backlogs were no longer a problem,

⁴LCA assigns 1 to missing or negative times. We use only data elements that are positive and drop all missing or negative numbers. Also, the times plotted for the distribution segment depicted in Figure 4 begin with the document date and end with departure from POE, a segment not typically reported by LCA.

⁵Because backorders have been removed from the data, this high variability is not caused by slow procurement or repair, but rather by numerous delays at each step in the process.

⁶Repair parts.

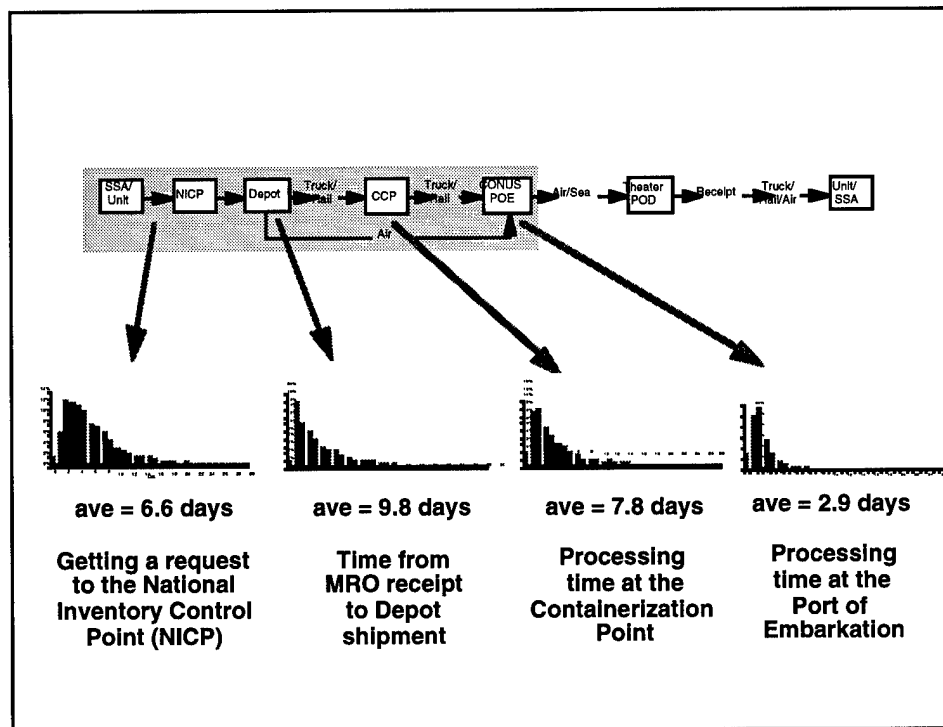


Figure 5—Variability in Segments

we still observe long tails (a high variance) in the relative frequency distribution of process times for overall time from document date to POE lift. Similar distributions with long tails were also observed for the individual segments between document date and POE lift.

We also checked the data to see if an order's priority or an item's cost made a difference. As Figure 8 shows, priority appears to have made a difference only at the depots; that is, only at the depot does the high-priority item (IPG1) move significantly faster than other priority items. This is because depots are less likely to bank high-priority materiel release orders (MROs). Note the slight negative impact of high priority on getting the requisition into the process (the set of bars labeled "Requisition to LIF Establishment"). This is due to additional, off-line management in the form of administrative checks.

Figure 9 shows the effect of cost. Cost had a large negative effect on the timeliness of flow through the item manager process at the NICP (the bars "LIF Establishment to Materiel Release"). It takes days longer to process a high-cost requisition. This is because organizations tend not to stock large numbers of high-cost items and because item managers target them for manual reviews. Manual review, as Figure 9 suggests, adds days to the item manager's part of the distribution process.

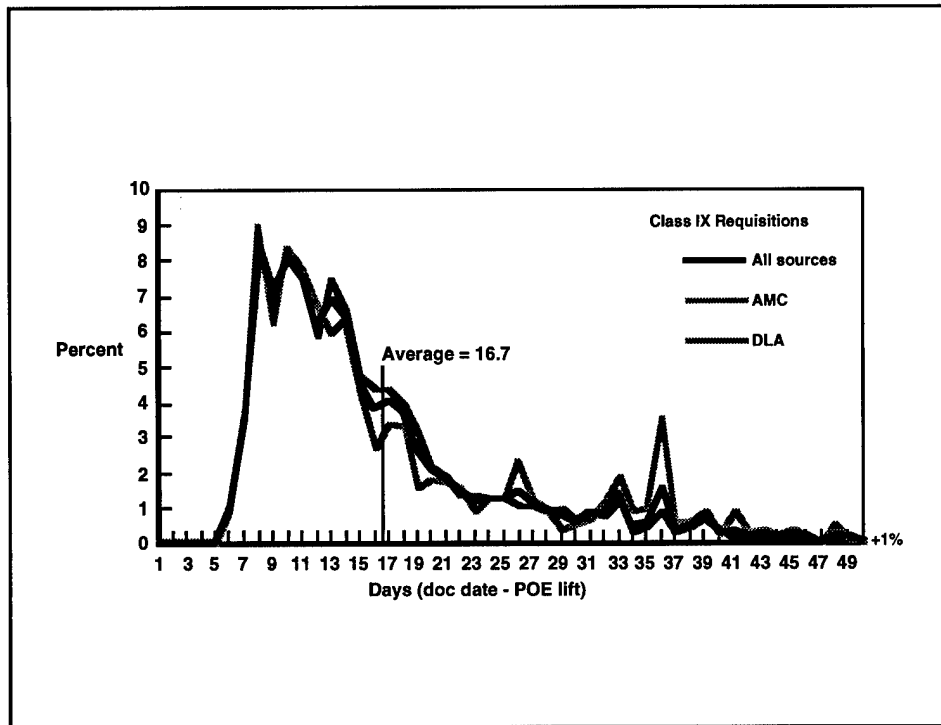


Figure 6—Time for Class IX Items from Order to Leaving CONUS POE: Somalia

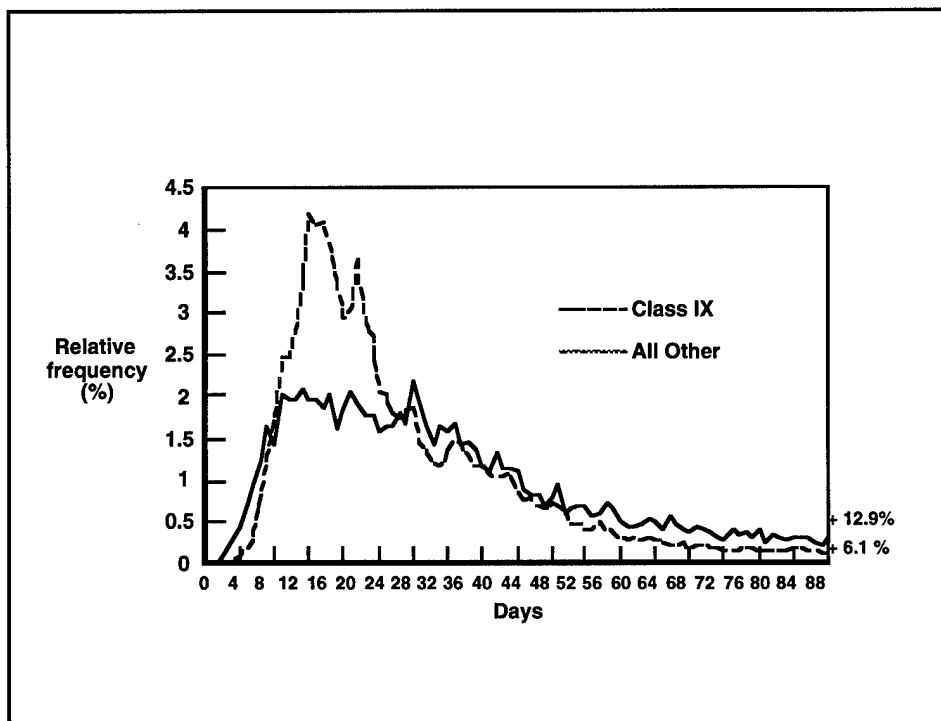


Figure 7—Time from Order to Leaving CONUS POE: Peacetime

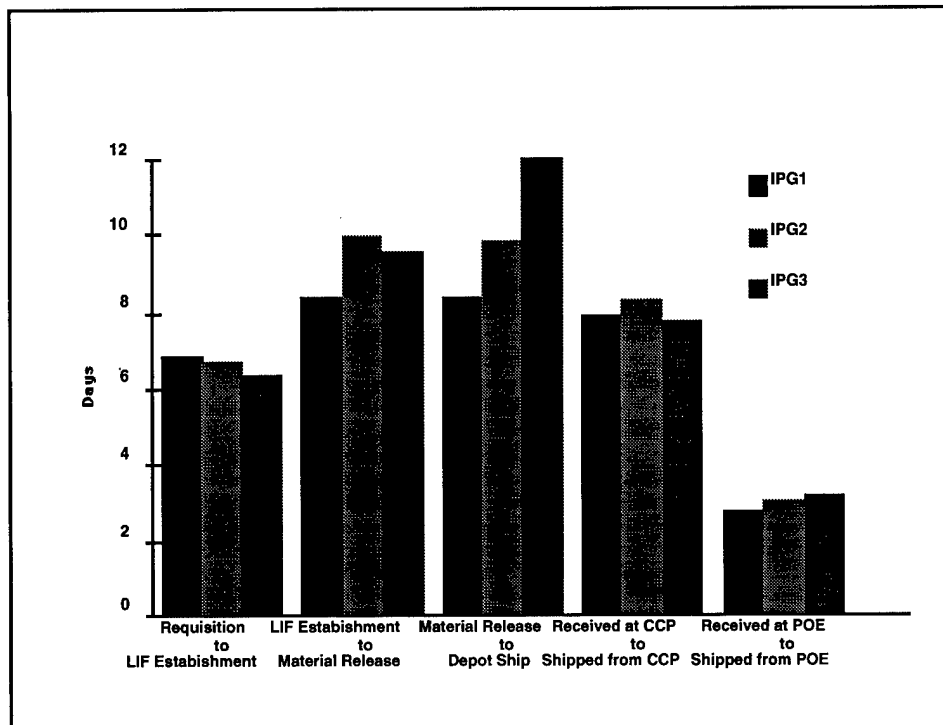


Figure 8—Effect of Priority on Average Processing Time Within Distribution Segments

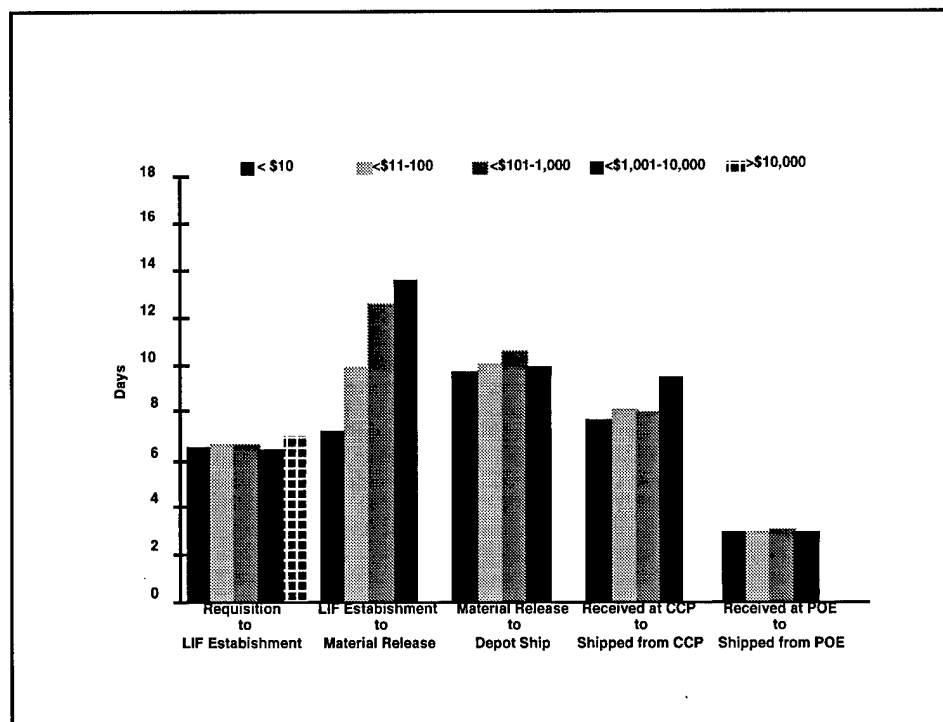


Figure 9—Effect of Cost on Average Processing Time Within Distribution Segments

EXAMPLES OF THE SOURCES OF POOR AND VARIABLE PERFORMANCE

No one organization or problem causes these delays. An error in the original order—the wrong address, quantity, or stock number—can cause the order to be diverted, rejected, or held for special management action. If the order is for an expensive item or requires high-priority transit, it is often diverted for administrative approvals. If the stock number has been changed at the wholesale level but not at the retail level, it will be rejected at the retail level as the wrong item. Batch data systems that are not coordinated throughout the process can cause orders and materiel to wait one or more days at each step. Further, wholesale depots and retail stock organizations often banked⁷ MROs to smooth their workload. We have seen MROs banked from one to three weeks at different organizations. Batch information systems are also not always run daily, which further slows the flow of requisitions. Lastly, some batch systems are shut down monthly for one or more days to process internal management reports.

Some anecdotes uncovered during the course of our study further illustrate the wide variety of the problems that occur and their effect on the units. These anecdotes illustrate four different systemic problems in the distribution process:

- Lack of a systemic approach to eliminate recurring errors
- Repetitive requisitions that result from slow updating of stock numbers (e.g., poor cataloging)
- Increased administrative processing for high-dollar items
- Customer distrust

Elimination of recurring errors. An error in a hand-entered DODAAC (reversal of two numbers) led to a large order of materiel being delivered to the wrong address. The mistake added extra transportation costs because the materiel was returned to its origin and reshipped to the correct address. It cost the unit that received the erroneous shipment staff time to correct the billing, and the original customer had to wait a long time for the order. What was most disturbing was that this same error had happened three times. The process lacks any authority or mechanism to see that specific types of distribution errors, once identified, are fixed so that they do not recur. Identification and correction of errors is a critical component to bringing a process under control but difficult to carry out in a fragmented process.

⁷To "bank" means to hold or store an order for future release.

Repetitive requisitions. Infinite "do loops" for items with different national stock numbers (NSNs) can occur. NSNs change because of a modification in the item or a new supplier. If that new NSN has not been entered into the Army Master Data File (AMDF) and hence the base supply computer (a process that can take six to nine months), the installation Central Receiving Point (CRP) will return it, thinking that the depot has sent the wrong item. The depot manager will reship it, and the process will repeat itself. This type of error also imposes multiple costs. First, it costs for the staff and carriers to ship the part back and forth from the depot. Second, the customer waits a long time for the part. Third, installations have developed time-consuming manual procedures to identify these items. This additional check further slows delivery. It appears that no one has the authority to fix the AMDF updating process to minimize this type of error.

Administrative process of high-cost items. Because of the Defense Business Operating Fund, base commanders have directed more attention to controlling their costs. Although such concern is desirable, it has a perverse effect on the requisitioning process. On at least one installation, orders over \$500 must be approved before they can go forward, and orders over \$2,500 require additional approval. This manual attention to costs, particularly for expensive items, lengthens the requisitioning process for many items, and in time this drives up the cost of inventory to fill these long order-fulfillment pipelines. We also observed that some retail and wholesale organizations will shut down their data systems that process requisitions for one or more days to prepare internal management reports. No orders flow during these periods.

Effect on customer behavior. Unreliable and slow performance affects customer behavior. Poor performance leads to distrust of the process, which can lead to rational but counterproductive coping behavior that often exacerbates performance problems. On the other hand, good performance builds customer trust, which can even help performance when customers are willing to share spare supplies because they know the process will replace them quickly. Figure 10 illustrates the effect of performance on behavior.

There are numerous examples of how poor performance—or the perception of poor performance—affects customer behavior. In DoD, units often deploy with higher-than-authorized levels of stock because they do not trust the current distribution process to fill their orders promptly. And when resupply takes too long, units tend to reorder or order more than they need.⁸ Before DoD can change this very rational coping behavior, it will have to

⁸One Desert Storm brigade commander stated that he would order four tank engines for every one that was needed to ensure the arrival of one. See *U.S. News & World Report*, May 31, 1993, p. 31.

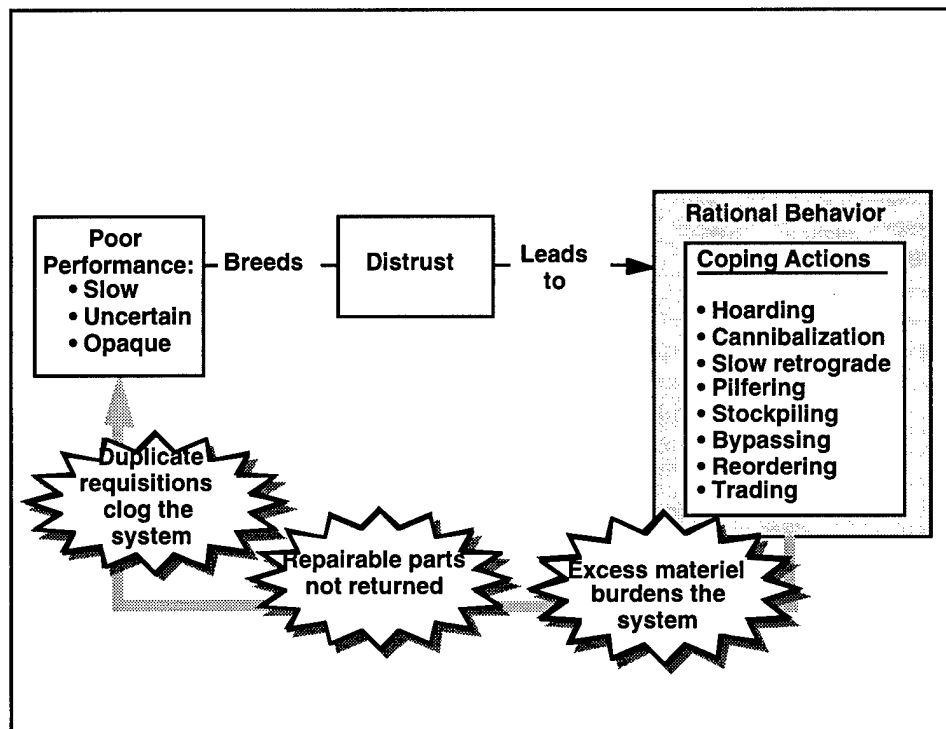


Figure 10—How Performance Affects Behavior

gain customer confidence in reliable and responsive order fulfillment⁹ during peacetime and design a wartime process whose performance will not be dramatically worse. All of these and other actions listed above use up valuable transportation assets, adversely affect deployability, and slow the remainder of the in-theater distribution process, which only fuels further distrust of the process.

On the other hand, when a process is performing responsively and reliably, it leads to customer behavior that further enhances performance. For example, the rival airline companies United and American share repair parts for aircraft they have in common. First, they know the favor will be returned. But, more important, they know they will quickly receive a replacement part through their distribution process.¹⁰

⁹This must include more responsive and reliable repair and procurement processes, both of which affect the frequency and duration of backorders.

¹⁰For example, Boeing Commercial Airplane Group provides next-day shipment of available routine spare parts orders—Airplane on Ground orders are processed and ready for shipment within two hours of order receipt, and critical orders are shipped the same day. The company estimates that one commercial air carrier will save \$18 million over three years by taking advantage of next-day spares shipments.

3. THE CHANGING WORLD OF DOD

DoD emulated the mass production industrial practices of the day when it created its current logistics support strategy and infrastructure to support a fairly well defined national security strategy and wartime scenario. Two underlying assumptions of this logistics strategy have changed. First, where, when, and how we plan to fight has become more uncertain. Second, a major paradigm shift has occurred in industrial practices.

Part of the driving force behind the shift in industrial practices are the changes that have occurred in the costs and capabilities of critical aspects of distribution: materiel, transportation, information, and communication.

MATERIEL COSTS

Modern weapon systems have greatly enhanced capability compared with previous generations. That improved capability was graphically demonstrated during ODS. But increased capability comes at a price. Table 2 indicates the size of that price by comparing the percentage increase in constant dollars cost between two generations of weapon systems performing the same mission. This is not to suggest that all components have increased as much or that some have not actually declined in cost. The point is that many of the items in the distribution pipelines today cost much more than they did 30 years ago (e.g., Meals-ready-to-eat cost about 50 percent more in constant dollars than the C-rations they replaced). In fact, today's distribution processes may want to distinguish between expensive items and less-expensive ones as well as customer need (priority).

Table 2
Percent of Cost Increase Between Generations of Weapon Systems
(In constant dollars)

Component	Model		Percent Increase
	From	To	
Aircraft engine	J 79	F 100	244
Fire control radars	APQ 156	APG 63	1,016
Helicopter engines	T58 GE	T 700-4	353
Ammunition	8"	MLRS	419
Missiles	Nike	Patriot	306

The Defense Logistics Agency (DLA) has recognized these increasing materiel costs, and under the umbrella of a "Buy Response Vice Inventory" (BRVI) goal, it is moving forward with a Direct Vendor Delivery initiative that has a goal of 50 percent of all sales (except fuels) delivered directly from the vendor and thus not stocked. Other programs within BRVI include Electronic Commerce/Electronic Data Interchange (EC/EDI), long-term, multiyear contracting, just-in-time delivery, best value contract awards, and prime vendor, all aimed at reducing the value of depot inventory and materiel in the distribution pipeline and improving customer satisfaction.

TRANSPORTATION COSTS

But if materiel has become more expensive, other things have become less so. One of the most striking examples from the DoD perspective is the cost of commercial shipping, shown in Figure 11. It shows the changes in cost per ton/mile for four modes of shipping: air, sea, rail, and truck. Shippers' charges in constant dollars-per-ton-mile have *decreased* from 30 to 60 percent over the last 25 years. Simultaneously, commercial materiel movement has become faster and more reliable. Thus, shipping not only costs less, it also gets more things there sooner and more reliably. The DoD should rethink its policies on the management of shipping costs given these impressive cost decreases.

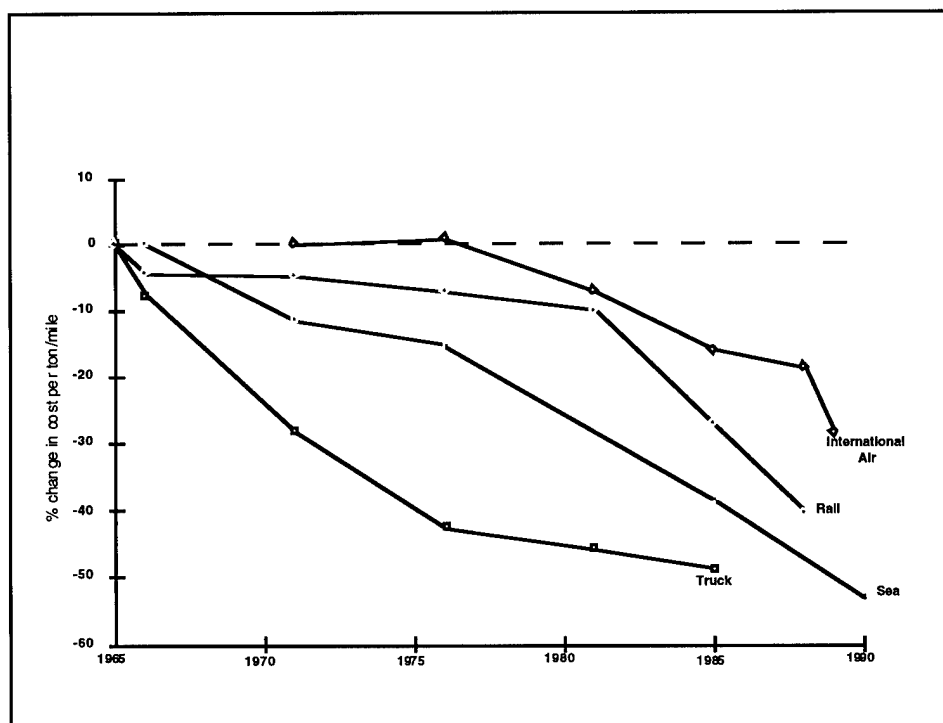


Figure 11—Cost of Commercial Shipping

DLA is exploring the process of giving DoD customers a choice of shipment modes at different prices. It also established a partnership arrangement with Federal Express Logistics Services to locate expensive and high-priority materiel at DLA's Memphis depot for quick shipment to customers who are willing to pay a premium for storage and shipment.

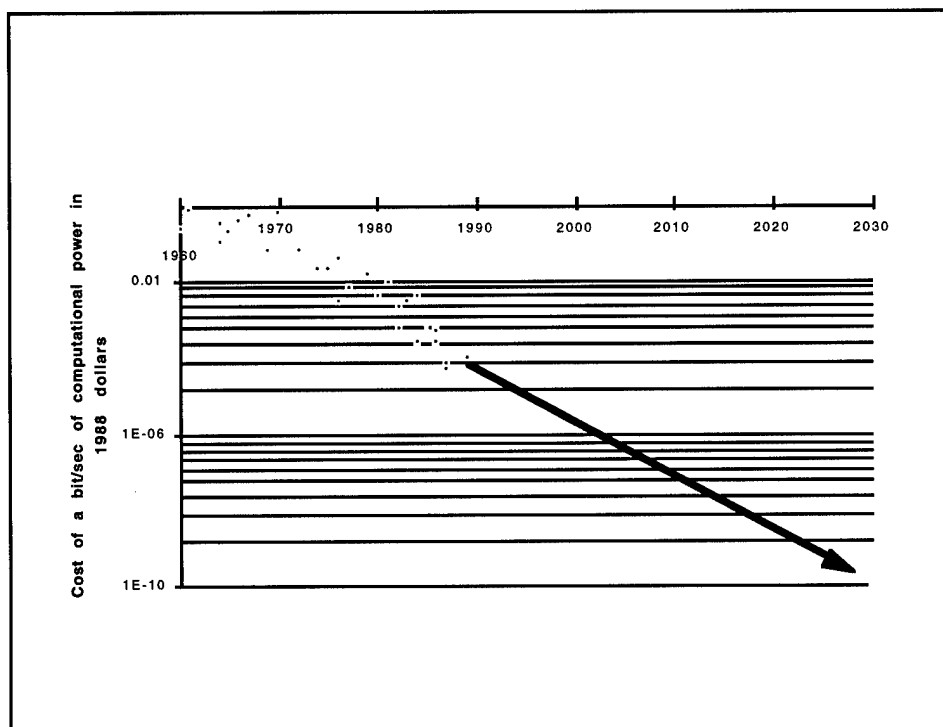
Although DoD transportation expenses are large—an estimated \$714.76 million in the FY94 Defense Business Operating Fund (DBOF)—they only account for 0.8 percent of the expenses of that fund. The cost of materiel sold from inventory, \$35.9 billion, comprises 42 percent of the FY94 DBOF expenditures. On any given day, DoD has \$98.4 million worth of materiel enroute to its customers. And DoD must buy materiel to fill this pipeline. Thus, a day of pipeline costs saved for all DoD customers translates into nearly \$100 million less stock DoD has to buy.

Unfortunately, the costs of decreasing the distribution pipeline time may occur in one DoD organization (e.g., DLA ships materiel through faster but more expensive channels) while the savings accrue to another (e.g., the services require less retail stock). Without the ability to transfer some of those savings from the gaining organization to the organization facing increased costs (e.g., from the services to DLA), there is little, if not a negative, incentive to make such systemwide improvements, particularly within today's tight budgets.

COMPUTING AND COMMUNICATIONS CAPABILITY

Trends in information and communication over the past 30 years have created major new opportunities. Cellular phones, modems, super computers, and powerful laptop computers provide capabilities today that were unavailable in the 1960s. Many have noted the exponential decline in computing costs illustrated in Figure 12, and there is no sign that the trend is leveling off. The cost of commercial off-the-shelf software is also beginning to decline. (Using commercially available software and techniques such as object-oriented and modular programming makes software changes easier and provides building blocks for future programs. This creates an opportunity for future time and cost savings on software production and maintenance.) Lastly, a number of companies have developed transportation, distribution, and warehouse management software that they will customize for specific customers at a much lower cost than developing a management system from scratch.

Even more important for logistics, an incipient explosion of world communications is under way (data rates, connectivity, new services, aggressive world standards). And, as Figure 13 shows, the costs of many modes of communication are dropping. The figure depicts the percent decline in constant dollars for various communications services between 1985 and 1994. Studies such as the Jason Global Grid study (Press et al., 1992) predict that



DATA SOURCE: Moravec (1988).

Figure 12—Decline in Cost of Computing Power

communication capacity and connectivity will be available as needed at corps level and above.¹¹

These advances in information and communications have enabled many organizations to shift from slow, labor-intensive, and expensive paper methods of ordering, shipping, and tracking materiel to highly automated, electronic systems that are quick and reliable and cost pennies per order. As these transaction costs have fallen, the economic-order-quantity and inventories have also fallen. That is, smaller, more frequent shipments have become more cost-efficient. The challenge for the DoD is to acquire communication and information systems quickly to take full advantage of the new opportunities created by advances in information and communication.

The Army distribution process may have made very good sense when materiel was cheap relative to the transaction costs of ordering and delivering it (e.g., transportation, information, and communications). It does not make sense today when materiel costs much

¹¹The study predicts two global grids: one orbital and one terrestrial. These redundant systems will offer three types of interconnections: grid-to-grid, user-to-orbital grid, and user-to-terrestrial grid.

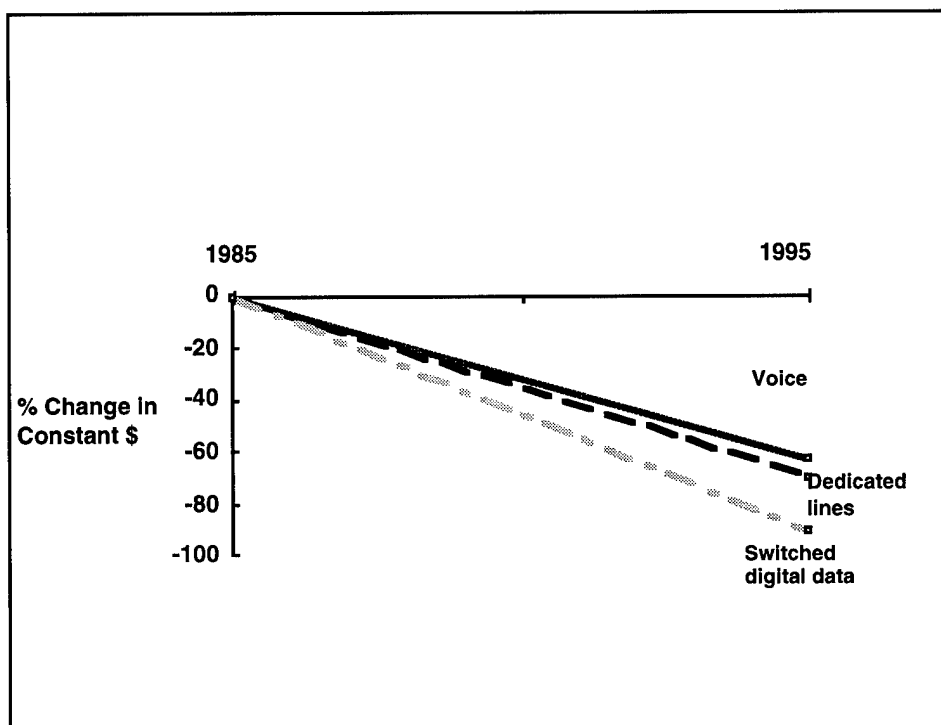


Figure 13—Decline in Costs of Communications

more and when order transaction costs are much cheaper and logistics providers are much more capable.

The changes in computing and communication described above grant logistics managers a capability today that was not present when the foundations of the current distribution process were laid. Furthermore, information collection strategies are now possible that would have been simply impossible previously. Industry has recognized these changes and, as we will discuss, is changing its distribution processes to take advantage of them. The DoD has also begun to recognize these changes. (Office of Deputy of Under Secretary of Defense (Logistics), 1995b.) It has set goals to:

- Reduce logistics response times
- Develop seamless logistics systems
- Streamline logistics information

4. A DISTRIBUTION EXAMPLE FROM INDUSTRY

As part of our analysis for ways the Army can respond to the changes described in the previous sections, we visited several companies with high-performance distribution processes. Caterpillar Inc. (CAT) is one of the best. It delivers parts available in its commercial inventories much faster than DoD delivers similar materiel from its inventories. Figure 14 compares Caterpillar wholesale distribution with that of DoD during peacetime. Most of Caterpillar's parts (99 percent) are delivered within two days. DoD's orders trail out over 35 days. DoD backorders have been removed from these figures. Parts that are not available in a local CAT dealer's stock are likely to arrive within two days. By contrast, parts not available in a unit's Authorized Stockage List are likely to take weeks to arrive from the DoD wholesale system. Table 3 compares Caterpillar distribution with that of the DoD for the same CAT parts in stock at CAT distribution centers and DoD depots directly before, during, and after ODS. OCONUS destinations are Korea and Southwest Asia.

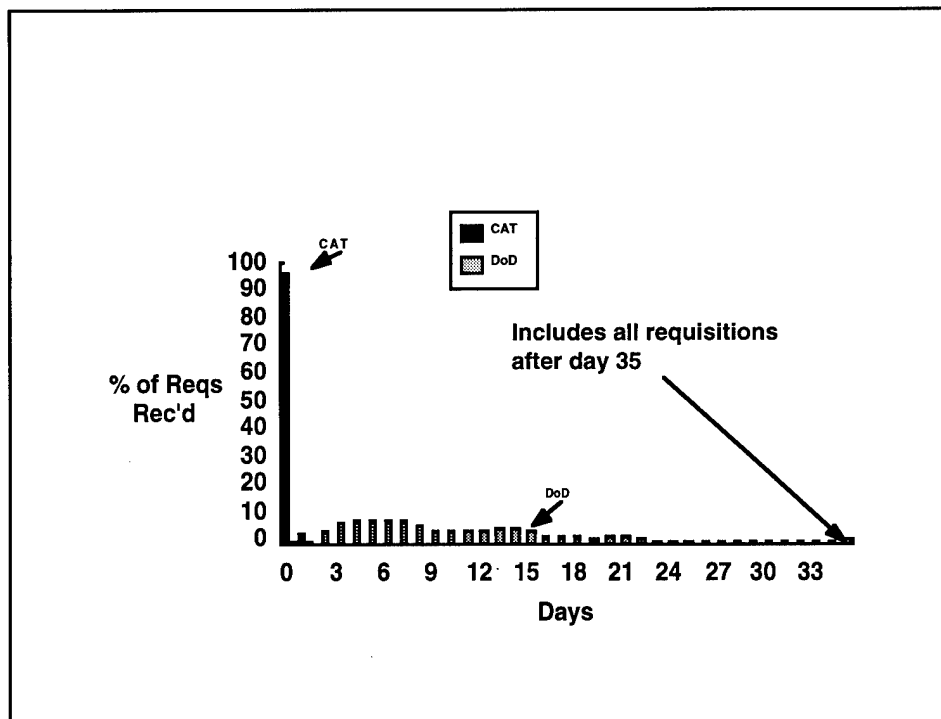


Figure 14—A Comparison of Caterpillar's and DoD's Wholesale CONUS Delivery Performance

Table 3
Caterpillar and DoD Wholesale Delivery Times for CAT Parts

	Delivery time in days	
	CONUS	OCONUS
Caterpillar	1-2	2-4
DoD		
Pre-ODS	13-23	21-66
ODS	21-36	47-48
Post-ODS	14-26	50-68

NOTE: No backorders.

We obtained from CAT the amount and cost of DoD orders in 1991 and 1992, from which we estimated the value of one day of DoD CAT part orders to be about \$60,000.¹² Thus, ten extra days of order fulfillment time requires an additional \$600,000 of stock. CAT estimates that about 50 percent of DoD requisitions for CAT parts do not go through the DoD wholesale system.¹³

CAT achieves high-level performance. It ships about 84,000 items per day. CAT has two types of orders: emergency (customer has an item of equipment inoperable because it needs a part) and dealer restock. About 46 percent are the first type and about 54 percent are the second type. Emergency orders are filled quickly. CAT guarantees 48 hours in CONUS or to the air or sea port for most parts or the customer does not pay.¹⁴ CAT dealers relatively close to distribution centers are restocked daily.¹⁵ Dealers in more remote locations get weekly shipments. If we consider the effect of local stock, we find that CAT delivers 99.8 percent of its high-priority parts orders within 48 hours or less.¹⁶ (See Figure

¹²We note that past DoD orders to CAT vary widely (e.g., DoD will order 1,000 or more of one item one year and none the next). Most commercial industries no longer order large quantities for bulk delivery and storage. Instead, they write long-term contracts for delivery of items as needed. DLA is in the process of establishing similar arrangements with its suppliers.

¹³DoD units in need of CAT parts to meet their readiness goals frequently buy parts directly from CAT dealers or go through intermediaries (COPARS/GOPARS) to get the parts quicker. One Army unit reported that 49 percent of its GOPARS purchases were not only quicker but also cheaper than those through the DoD normal system.

¹⁴Typically, for parts for newer equipment. However, CAT supports all equipment it has ever produced.

¹⁵Rapid restocking allows these dealers to have more breadth and less depth of stock and a higher order fill rate for the same investment.

¹⁶One CAT dealer we visited has about \$1 million in stock and does about \$600,000 in business each month.

15.) And for the 0.2 percent of the parts on backorder, suppliers deliver over half of those in 5 days or less.¹⁷

CAT achieves high performance by having long-term contracts and electronic connectivity with its suppliers and contracts with ten large shipping companies.¹⁸ CAT has over 250 independent dealers worldwide and 22 parts facilities around the world. The company recommends a stock level to dealers based on the number and types of CAT equipment in the dealer's service area. Dealers are connected electronically to CAT's distribution centers and other dealers. If a dealer does not have a part, the system will search worldwide for the nearest available replacement.

Figure 16 depicts Caterpillar's distribution process. When compared with that of the Army (Figure 1), two aspects stand out. First, the system has far fewer nodes. For example, CAT does not have item managers. Instead, it has an information system maintained by a staff of about 25 that performs item manager-like functions as well as parts location and

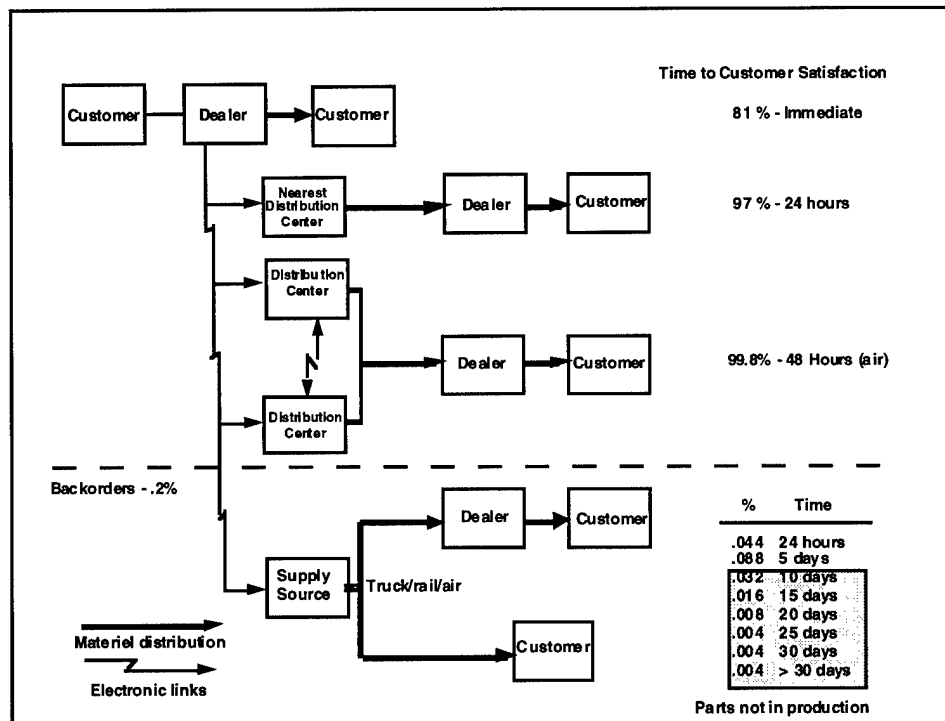


Figure 15—Caterpillar Replacement Parts Distribution System

¹⁷The remainder of the backordered parts are primarily for very old CAT equipment.

¹⁸CAT has 480,000 line items it services worldwide, of which it stocks 320,000. In addition, dealers typically stock about 40,000 to 50,000 line items.

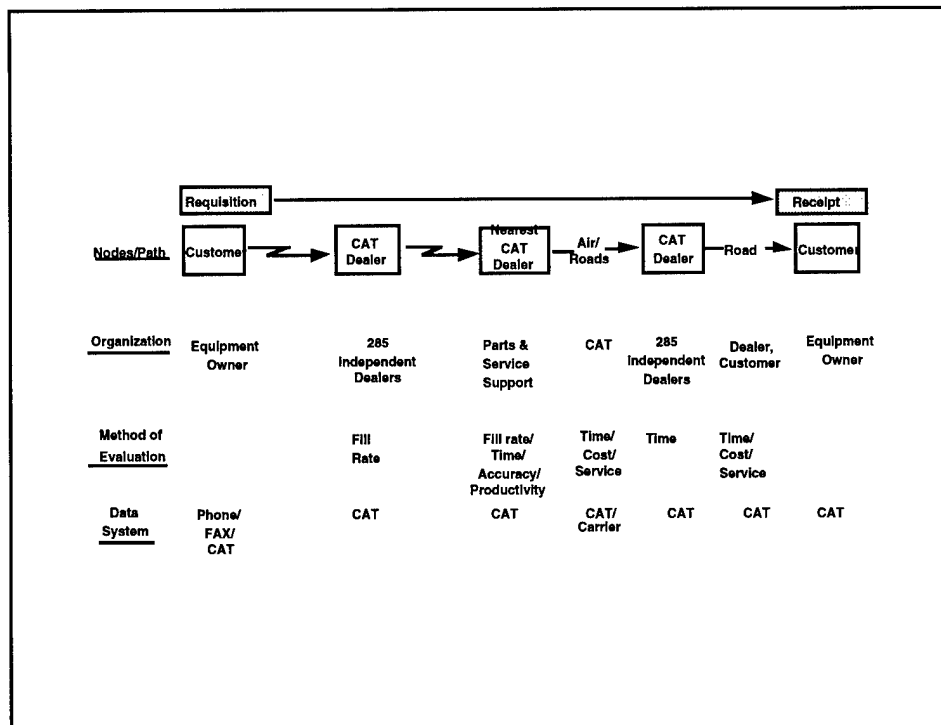


Figure 16—Caterpillar's Distribution Process

distribution functions. Second, and perhaps more important, those nodes are linked by a uniform data system and an overarching performance goal: customer satisfaction. Caterpillar obtains high performance by electronically linking its worldwide network of over 250 independent dealers and 26 distribution centers, by setting high standards, and by demanding high performance of itself and its suppliers and contract carriers.

Caterpillar's distribution system does not compare with every aspect of the DoD process. It does not move large quantities of commodities such as food or fuel. It resupplies a modest volume of spare parts through a geographically dispersed system. The equipment requiring parts has a well-established demand history (unlike a lot of DoD equipment that only rarely operates in the environment for which it was designed), so the company knows which parts to stock in the field and which to store centrally. The point of the comparison is not that Caterpillar faces the same challenges that DoD faces. But in certain dimensions, Caterpillar's operation resembles DoD, which also must resupply a relatively low volume of spare parts. And along those comparable dimensions, Caterpillar has been very successful by applying certain techniques, in this case a simple distribution structure and a linked data system and high performance standards. Those techniques may offer DoD similar benefits.

A frequently heard objection to applying commercial approaches to DoD distribution is that the differences are so great that the practices would not transfer well. Differences include:

- Predictability of surge requirements,
- Wide range of items,
- Nature of the customer environment,
- Need to develop capacity to new areas,
- Funding,
- Contracting.

Unarguably, inherent differences exist. Although companies have surges in their business, normally they are smaller and more predictable (e.g., Christmas) than what DoD will face during a contingency.¹⁹ Companies know their retail customer's environment, which is generally safe. Companies typically deal with specific types of materiel, such as food or electronics or repair parts, while DoD must deal with a broad range of materiel from beans to boots to bullets. DoD also has some very complex, highly sophisticated equipment that presents support challenges seldom found in the private sector. DoD's customers deploy to unknown and decidedly hostile places. A firm's customers are usually stationary, while DoD's often move.

As shown, DoD's distribution process does not achieve high performance in peacetime and fares worse in contingencies. The latter is a difference with commercial companies, who rarely have to suddenly develop new distribution capacities.

Companies draw their funds from investors, and those funds are very flexible. Congress provides DoD's funding, and those funds are currently earmarked for specific functions such as stock, repair, and so forth. Industry's contracting also tends to be more flexible.²⁰ It can sign long-term contracts with the best suppliers, while federal regulations often constrain DoD's choice of contractors and acceptance of bids. Unpredictable or variable DoD funding also leads to more short-term contracts.

Finally, industry, while it spends considerable time designing and testing information systems, acquires and deploys them much faster than DoD, which must go through lengthy design and selection processes and then often a phased deployment over a number of years to match funding.

¹⁹Federal Express claims that ODS sustainment was equal to its Christmas surge.

²⁰Some DoD agencies are experimenting with long-term and best-value contracts.

But some differences are not inherent and perhaps should be eliminated. For example, businesses always focus on the customer. DoD concentrates on the customer in war, but in peacetime the focus falls on efficiencies and often localized efficiency, employing such techniques as minimizing transportation costs by holding materiel to balance workload or for consolidation, which drives up inventory costs.

These differences notwithstanding, commercial operations compare with DoD in many ways. For example, a number of companies have comparable—or greater—size and volume. ATT has 1.5 million line items. Caterpillar averages a daily wholesale order volume of 78,000. In terms of shipments, UPS moves 11.5 million packages daily, Federal Express 1.5 million, and Yellow 42,300. The information system that tracks UPS packages could just as easily track bills of lading, which tend to be fewer. Federal Express serves 174 countries.

Again, the point is not that these companies have identical operations to DoD, but that they address similar problems, sometimes of much larger magnitude, and do so more successfully than DoD. The ways in which commercial firms have overcome similar problems and achieved high performance may be very instructive to DoD. In the next section we discuss how industry changes might be adapted to DoD.

5. ADAPTING INDUSTRY CHANGES TO DOD

Like the DoD, commercial suppliers face a similar challenge of doing more with less. Domestic and international competition have increased dramatically. This competition and the need to meet stockholder expectations are generating strong pressures to improve products and reduce costs. Customers have become more sophisticated, diverse, and broadly distributed, and they are demanding more reliability, responsiveness, ease of interaction, and visibility of their orders. They also face similar changes in the relative costs of materiel, transportation, information, and communications as well as the increased capabilities and opportunities technology provides. The best U.S. firms have responded positively to these pressures and opportunities.

We identified six common strategies that leading companies have used to improve their performance.

- Define business focus and core competencies
- Focus on customers
- Establish well-defined customer-supplier relationships
- Establish process managers
- Change process, organizations, and procedures and leverage technology to meet customer needs
- Establish ambitious goals and measure performance.

These are all activities that DoD and the Army either do not do at all or do not do well. We focus now on adapting the above industry strategies to improving overall materiel distribution.

DEFINE BUSINESS FOCUS AND CORE COMPETENCIES

In looking at different strategies for defining core competencies, we first look at organizational structure because DoD tends to take this approach when looking for both cost and performance improvements. We observed that leading companies have taken different organizational approaches to distribution. Figure 17 shows three companies with high materiel distribution performance. At one extreme is Federal Logistics Services (FLS). Its parent company, Federal Express, is primarily a shipper, but FLS provides logistics services such as materiel distribution. FLS, through Federal Express, "owns" almost all of its express distribution processes (assets and people). At the other extreme stands Caterpillar Logistics

Services (CLS), which provides logistics services to its parent, Caterpillar Inc., a manufacturer and supplier of heavy equipment, as well as other third-party companies. CLS "owns" warehouses but not the transportation segments of its distribution processes or its dealers. It gets its high performance by forming partnerships and executing contracts with high-performing shippers and their dealers. American Presidents Lines (APL), a major distributor of bulk cargo, owns some transportation assets (e.g., ships, containers, trailers) and thus falls somewhere in between FLS and CLS. APL uses a combination of ownership and partnerships and contracts to get its high distribution performance. For example, APL went from a port-to-port steamship company to a point-to-point intermodal distribution and logistics services company. APL does not own many of the ships, trains, or trucks that move the containers of cargo it manages. Yet it delivers parts from Japan to a Tennessee Toyota manufacturing plant within 15-minute windows using partnership relationships. These three very different examples of high-performing materiel distribution companies suggest that improvement can occur across a spectrum of organizational approaches.

Once they have identified their core competencies, DoD and the Army should contract out distribution activities that others can do better. For example, the Air Force used to operate a Log Air Service for delivering spare parts within CONUS. Several years ago it

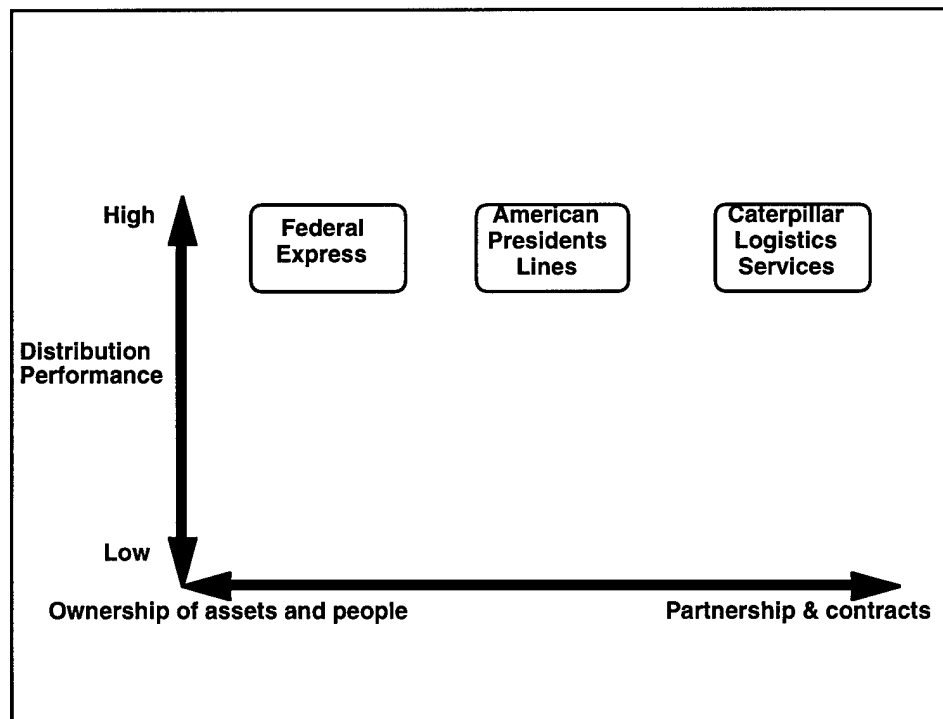


Figure 17—Different Approaches Used by High-Performing Companies

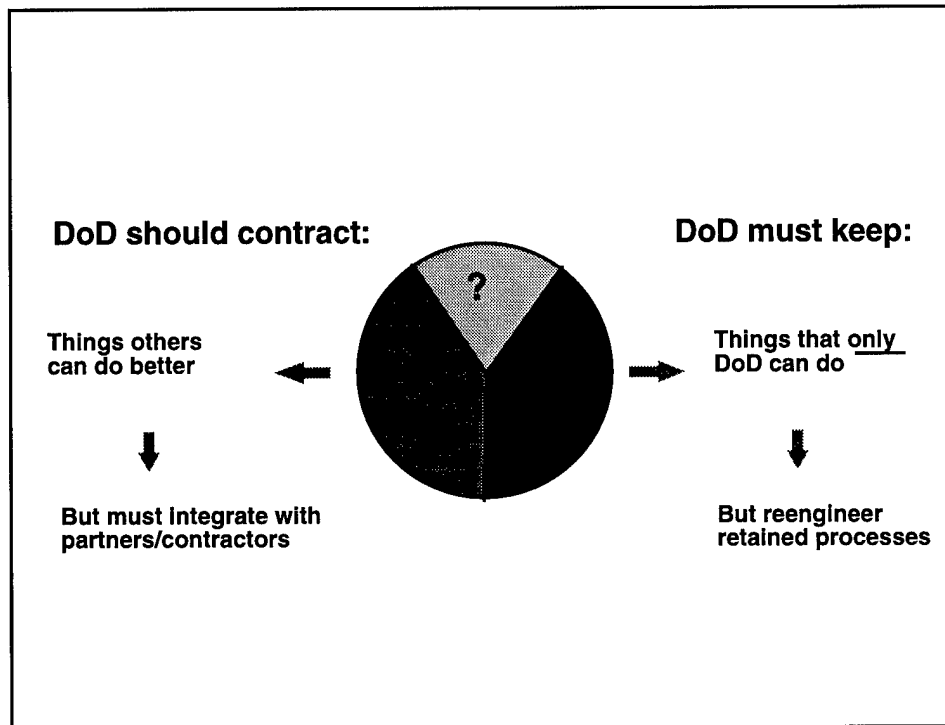


Figure 18—Focusing on Core Competencies

contracted this function to overnight carriers, and late deliveries were halved and costs dropped 70 percent, or \$83 million per year. But DoD and the Army must integrate their retained processes, information systems, and management (e.g., doctrine, policies) with their commercial contractors. This also requires a shift from a more adversarial, hands-off relationship with contractors to a partnership based on mutual trust and goals. Further, it means the additional loss of DoD jobs, which is already a painful process.

FOCUSING ON THE CUSTOMER

Focusing on the customer requires a significant cultural change for DoD and the Army. They must move from a compliance orientation based on rules and regulations and risk avoidance to a mission orientation that focuses on warfighting capability and customer requirements. The current culture slows materiel distribution by requiring multiple approvals, highlights rather than reduces organizational boundaries (the latter being needed for a seamless process), and is relatively inflexible to differing customer needs.

Focusing on the customer also requires that the DoD and Army shift from a functional orientation that promotes local performance measures and relatively independent, almost adversarial, operations to a process orientation that focuses on systemwide performance and

team operations. The current culture drives up the cost of materiel distribution because decisions are made based on local costs (e.g., transportation), not overall systemwide costs.

The best-managed companies concentrate on customer satisfaction. The DoD, on the other hand, has focused on priorities, which are supposed to support the customer but in reality largely manage costs and, to a lesser extent, resource constraints, but do not necessarily satisfy customer needs. Industry is currently focusing on responsiveness to customer needs, orders, and problems. While elements of the DoD distribution process are beginning to move in this direction, many still try to maximize their cost savings, particularly in transportation.

CUSTOMER-SUPPLIER RELATIONSHIPS

Because there are multiple steps and players, as Figure 1 shows, DoD needs to create much better customer-supplier relationships among all of the DoD organizations and commercial contractors involved in materiel distribution. For example, the Consolidation and Containerization Point is a customer for inbound shippers and a supplier to outbound shippers. This requires performance standards contracts or agreements. Thus, trucks should be required to be on time to the CCP with the necessary shipping and content information. And the CCP needs to provide materiel and information and documentation on time to its shipping docks. In the commercial world, businesses fine suppliers for poor-quality information and lateness. For example, Walmart fines suppliers for unreadable bar codes and refuses to do business with them after the third failure, and Saturn fines its suppliers if late deliveries shut down the production line. Well-defined customer-supplier relations also require performance incentives. In other words, just meeting performance goals is not good enough. Each player should strive for continuous improvement in multiple performance dimensions. The availability of information throughout the materiel distribution process is essential to plan and coordinate work, track orders, identify and solve problems, and measure performance. Lastly, cross-organizational teams are critical to identifying and fixing problems and continually improving hand-offs between each organization in the materiel distribution process. Otherwise, problems linger and fester and are never truly eliminated, and overall performance to the customer remains poor.

ESTABLISH PROCESS MANAGEMENT

We have seen in the commercial world that different organizational structures can achieve high distribution performance. However, somewhere there needs to be a process manager—a single point of contact with responsibility and accountability to the customer. Two models for a DoD distribution process manager have been proposed. The first, a single

manager or "vice president for distribution," is similar to the Federal Express model, where the company controls the process from when it picks up the package until it is delivered (most of the people and transportation assets). This is a simple organizational structure, but it does not always span the entire process, and more than 50 percent of DoD's materiel is moved by numerous commercial carriers. It would also be difficult to implement within DoD because the current structure is fragmented, as depicted in Figure 1. Further, some organizations involved in distribution such as USTRANSCOM have other missions, e.g., deployment.

The second model, "retain multiple managers for DoD's portions of the distribution process," is similar to the American President Lines and Caterpillar Logistics Services models. This model is more complex organizationally, and interfaces of materiel and information flows are critical between organizations and with customers. This model also requires cross-functional teams to ensure smooth hand-offs between organizations. This second approach is probably more acceptable and feasible given organizational parochialism. However, either option requires a single point of contact with responsibility and accountability to the customer.

Figure 19 shows DoD's collection of organizations involved in materiel distribution overlaid on our performance and organizational structure space. They are located in the lower portion of the figure because, as we have shown, DoD's current materiel distribution performance is low. DoD needs to select a process manager model and move in the direction that will improve performance.

Whatever model DoD chooses for a process manager, the process will have to be improved, organizations and procedures will have to be integrated, and technology will have to be leveraged if DoD is to attain the high level of materiel distribution performance seen in leading commercial companies. As we have indicated earlier, there are moves in this direction. Transportation services have been consolidated under USTRANSCOM. DLA is working to improve its performance and reduce costs. It is testing long-term, best-value contracts with manufacturers and vendors. The services have ongoing programs, such as the Air Force's lean logistics and the Army's velocity management, to speed repair and distribution and reduce inventory costs.

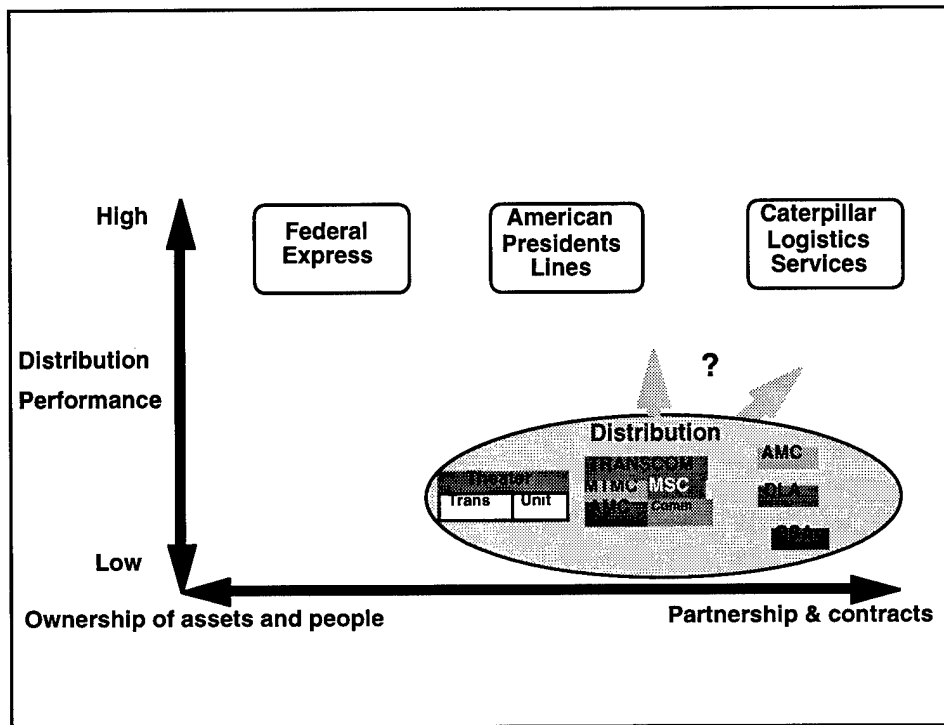


Figure 19—DoD Process Management Choices

CHANGE PROCESSES, ORGANIZATIONS, AND PROCEDURES AND LEVERAGE TECHNOLOGY TO MEET CUSTOMER NEEDS

Leading U.S. firms have also made themselves more competitive by changing their internal organization and procedures, by leveraging technological advances, by redesigning processes so they can fully exploit technological changes, and by improving product design. These firms have increased productivity and quality, decreased costs, and improved customer support. For example, reliable door-to-door overnight air express services 95 percent of the people in the United States.

Industry has achieved its greatest gains in productivity and efficiency from a combination of process reengineering that takes maximum advantage of the current powerful technology and reorganizations to support the new processes. Some examples of technological change in the distribution industry are railcars, ships, and computers that have become faster and larger. Air and sea containers were introduced to speed loading and unloading, reduce theft and breakage, and enhance asset management. For example, APL invented and gave double-stacked container railcars technology to the railroads to improve the efficiency of land movement of containers. And it designed post-Panamax ships, which

are more stable and efficient for trans-Pacific shipping.²¹ Automation and electronic data interchange have increased speed and accuracy of orders, production, warehousing, billing, and tracking. And information systems have been used to improve customer support, resource management, and employee productivity. APL is currently reengineering its processes to take advantage of radio frequency chips, placed on containers and chasses to improve and speed identification.

Examples abound of U.S. companies that have reengineered and reorganized to decrease costs, increase productivity and quality, and stay competitive. Bell Atlantic measured a process and found it had 13 different steps that required an average of 15 days to complete but involved only 10 hours of actual work (Hammer (1990), pp. 104-112). While these management changes have been very painful for many employees and the companies themselves, companies have emerged stronger, more flexible, and more resilient. For example, Cummins Engine reduced its inventory from \$173 million to \$22 million.²² Today Cummins supports more engines and more different types of engines with less inventory. Overall, companies have reduced their inventory and increased inventory turns an average of 30 percent. In addition, materiel transit times have fallen an average of 33 percent.²³ For example, Federal Express delivers 99.6 percent of its packages by 10:00 AM the next day; Caterpillar guarantees 48-hour delivery of many parts or the customer does not pay; and Tileflex has improved its on-time delivery from 15 to 80 percent.

Table 4 compares the estimated benefits of automating an existing process (the sort of automating DoD tends toward) with the actual gain achieved by reengineering the process to take full advantage of technology (Hammer, 1990; Hammer and Champy, 1993). Some specific case studies illustrate the point. General Motors invested heavily in automation in response to the challenge of the Japanese auto makers. But it simply automated the old mass-production process. It achieved only small gains in productivity, costs, and quality. On the other hand, Portland General Electric implemented complementary technological, organizational, and engineering changes. It got impressive results. Processing time dropped from fifteen days to only one-half day. The company estimates that automation alone would have produced only 10 percent of the time savings. Costs declined from \$90.00 per transaction to \$10.00 (Davenport and Short, 1990). Similarly, Ford Motor Company

²¹A Panamax ship is one that can pass through the Panama Canal. Post-Panamax ships are too wide to negotiate the canal and are more efficient because they carry more and ship cargo faster by unloading on one coast and shipping cross-country by rail.

²²Discussions with managers of the service parts distribution center at Cummins Engine, March 1993.

²³Cass Logistics Inc. presentation of data from Ohio State University.

Table 4
Comparison of Gains from Technology and Process Redesign
(Percent saved)

Savings	Technology Only	Technology + Process Redesign
Time	~10	97
Cost	~10	89
Labor	20	75

redesigned and automated its accounts payable operation and achieved a 75 percent personnel reduction (Hammer, 1990). It estimates that automation alone would have produced savings on the order of 20 percent. The rest of the savings results from a total redesign of the process. Automating cumbersome procedures does not make them less cumbersome. The greatest gains occur when the procedures are redesigned to take full advantage of available technological capabilities.

Companies that have changed their processes and use of technology have increased the quality and reliability of their products and service while increasing the speed of that service and ease of interaction between customers and suppliers. At the same time, these companies have lowered their costs of materiel, management, and labor.

But these changes have not occurred overnight or without costs, nor have they been a one-time effort. Many companies prototype and test new technology and processes before fully implementing them. For example, APL tested the use of radio frequency chips on containers during a move of an Army Signal Corps unit to Korea during an exercise. New information and communication systems, staff time for reengineering the process and for retraining, and consensus building and culture changes consume considerable resources and require a strong commitment from senior management and subordinate staff. Furthermore, the best businesses are continuously improving. They never cease looking for ways to improve their performance, reduce their costs, or leverage technology.

Leading companies are radically improving their performance by combining process redesign with technology, while DoD often attempts to improve its performance incrementally by applying technology to the current process.²⁴ Even this approach is becoming increasingly difficult for the DoD because its acquisition process for new

²⁴DoD's Corporate Information Management Initiative includes incrementally improving processes, but this is to occur primarily after information systems have been standardized across similar functions.

information systems is slow and cumbersome (often six to eight years). And the way funds are allocated for new information systems may drag out their deployment for years.

DoD has not seriously pursued process redesign because when change crosses organizational lines, it becomes more difficult if no one is in charge of the whole process (as is the case with distribution), to the point that some DoD personnel consider radical organizational change infeasible. Lastly, high-performing companies set high standards and get high performance, while the DoD sets comparatively low standards and does not consistently meet them.

ESTABLISH AMBITIOUS GOALS AND MEASURE PERFORMANCE

Given that DoD failed to meet its distribution time standards in the Persian Gulf War, we wanted to understand how much these standards had changed over time. Table 5 summarizes how time standards for low- and high-priority orders have changed since 1959. Surprisingly, not much progress has been made in reducing process and hold times. In fact, they have gotten longer, while standards for movement have decreased slightly. We also observe that there are no standards for retrograde, which tends to be very slow.

If DoD and the Army are to gain customer confidence, they need measures of performance that reduce the variability (i.e., the long tails). Leading companies like Federal Express not only measure themselves by absolutes for errors (such as 99.6 percent on-time

Table 5
Evolution of Processing and Hold Standards for Days Allowed

	High Priority				Low Priority			
	1959	1960	1980-92	1993	1959	1960	1980-92	1993
Requisition, pass, availability, storage, processing, receipt	3	2	5	4	10	11	18	12
In-CONUS hold, consolidate, transport	3	[5]	3	1	10	[34]	13	10
Total CONUS	6	—	8	5	20	—	31	22
European shipment, delivery	6		4	4	42		43	18
Total Europe	12	7	12	9	62	45	74	40

NOTE: Bracketed numbers include European shipment and delivery.

delivery), but they also classify their failures, that is, their tails, and work on ways to reduce them. In this way, they increase customer satisfaction. Table 6 illustrates Federal Express's approach to eliminating problems. On a daily basis, the company computes an average daily failure index by multiplying the number of times a particular failure occurs by the degree of customer aggravation. It then computes a Service Quality Index by summing the average daily failure points by type of failure. This process identifies the specific types of problems that occur most frequently and thus those the company must work on.

Quantitative research in other areas has demonstrated that when standards are high, have meaning, and are enforced, performance is higher (Rosenthal and Jacobsen, 1992). That is why companies set high standards, which they keep increasing. We are encouraged by OSD's new emphasis on reduced logistics response times. It has proposed a 72-hour delivery time for nonbulk materiel by September 1998 and a maximum 5-day delivery in CONUS. (DUSD(L), 1995a).

As important as setting high goals is the measurement of performance against those goals. DoD largely measures its performance in *averages*. This gives a false picture of

Table 6
Federal Express Service Quality Indicators

Failure	Degree of Customer Aggravation
Right day, late service	1
Wrong day, late service	5
Traces	1
Complaints reopened by customer	5
Missing PODs	1
Invoice adjustment requested	1
Missed pickups	10
Damaged packages	10
Lost packages	10
Overgoods	5
Abandoned calls	1
International SQI indicators	1
Includes delivery/service failures, abandoned calls, inventory adjustment, missing or late POD, traces, lost packages, damaged packages, complaints reopened, overages and shortages.	

performance that is highly variable. DoD needs to emphasize more appropriate measurement of performance and to use results to target and continually improve performance, as industry does.

Our research suggests that leading companies adapt much faster to their changing world (political, economic, and technology) than the DoD. One possible explanation might be that industry adapts faster because it focuses on different goals. Industry focuses on satisfying three groups: customers, boards of directors and stockholders, and employees. Yet when we examine DoD distribution, we see similar goals. Its operators are responsible to their customers (the units and CINCs), their employers (the public and Congress), and their staff (the service members and civilians who perform the various tasks throughout the distribution process).

So even though DoD has similar goals, it has not adapted to change with the same speed as industry. One result of the slower adaptation is that DoD's distribution practices vary considerably from those in industry. The differences in two areas stand out: customer focus and process redesign.

Change, especially radical change, is hard for any organization. It will be particularly difficult for the DoD, but the benefits could be substantial. Change starts at the highest level of the organization, with a corporate vision. OSD's 1994 Strategic Logistics Plan is a good start at developing and maintaining a consistent logistics vision. It requires sustained commitment (longer than the tour of a general officer) by senior leadership and cultural as well as organizational and procedural change. It also requires up-front investments in people and technology to redesign processes and organizations and to develop process-driven information systems. Further, the change has to permeate the organization. For example, not only does the distribution process have to change, but repair and procurement processes also have to become more responsive and reliable (i.e., reduce backorders) to meet customer needs.

Radical change is the only way DoD can realize the benefits that leading commercial companies have realized by improving their logistical processes. These firms are providing much faster, cheaper, and high-quality logistics services and are better meeting their customers' needs. DoD needs both the large cost savings and improved performance (to support our national security policy) that these commercial companies have achieved. In the next section, we summarize what we have found, recommend changes for DoD materiel distribution, and outline additional ways that we plan to help the Army and DoD solve this difficult and persistent materiel distribution problem.

6. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

In summary, we have learned so far that:

- DoD distribution is complex and compartmented.
- It is slow and unreliable, and the problems affecting it are longstanding and pervade the process. No single approach or technique will close DoD's logistics performance gap.
- Fixing it requires a systemic approach because past stovepipe approaches have not worked.
- The Army distribution process has evolved over many years and may have been good at one time. But it now rests on assumptions that are no longer valid.
- The best commercial firms have met and overcome many of the challenges confronting the DoD. We have observed the following aggregate level strategies at successful companies:
 - Define business focus and core competencies
 - Focus on customers
 - Establish well-defined customer-supplier relationships
 - Establish process managers
 - Change process, organizations, and procedures and leverage technology to meet customer needs
 - Establish ambitious goals and measure performance
- Their approach is a useful model for the DoD to explore.

Opportunities exist for large DoD cost savings and performance improvements. To achieve these benefits the DoD needs, in the short term, to improve the performance of its current processes and, in the long term, to change its processes to take advantage of advances in technology. Finally, the Army does not currently demand high logistics performance either from itself or its suppliers. As mentioned, the Army and DoD have recognized these problems and are taking steps to resolve them.

RECOMMENDATIONS FOR THE ARMY

We identified and discussed six common strategies that leading firms have used to improve their performance. First, the Army needs to clearly define its core competencies and mission focus. With respect to material distribution, the Army needs to focus on those parts of the process that it can improve and demand high performance from providers of other parts of the process. Second, the Army needs to focus on its customers and their performance needs. Third, the Army needs to establish well-defined customer-supplier relationships with both internal and external Army customers and suppliers. Fourth, the Army needs to establish a process manager for material distribution to act as a single point of contact for customers and suppliers and to manage process improvement efforts. Fifth, the Army needs to change its distribution process, organization, and procedures, and to leverage technology to improve performance to its customers. And, sixth, the Army needs to establish ambitious goals and measure performance of its distribution process. It is not enough to set goals. The Army and DoD need to measure performance relative to those goals. And to reduce variability, those measurements cannot be based on averages. For example, DoD did not meet its UMMIPS standards and did not know because measurements were based on averages.

Lastly, if the Army and DoD want to improve the materiel distribution process, they must create and maintain a broad consensus on the *need* for substantial change. Having achieved a broad consensus, they must make a long-term management and financial commitment to change. They have begun to create high-level teams (e.g., OSD's Logistics Response Time Process Action Team and the Army's Velocity Management Change Agent Team) to work with the system's customers to specify and refine materiel distribution goals. These goals should be stated in terms of customer needs for not only the process's responsiveness but its reliability, cost-effectiveness, and visibility.

Once goals are established, the DoD organizations and the Army should form teams with each other and look to leaders in industry for ideas to redesign the distribution process to meet the goals. Ongoing efforts, including the Army's Total Distribution Action Plan, the Army's and DoD's Total Asset Visibility, In-transit Visibility, and the Global Transportation Network, need to be evaluated in terms of their support of these goals and process improvement. A consensus on the new process must also be established, as well as new measures of performance that link to these goals.

Change can begin with the improvement of current processes. We have already observed that there is substantial room for improvement there. At the same time, DoD and the Army need to test and refine more radical improvements, followed by implementation and

monitoring. Some of the testing has already begun for selective items and systems. This ongoing testing can be expanded concurrently with the earlier steps. The Army has recognized the above and has embarked on a comprehensive Velocity Management Initiative to improve the performance of its major logistics processes to include material distribution.

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